

systems), peripherals, data storage systems and other device resources, as well as software programs or processes which operate within such resources. More specifically, embodiments of the invention provide unique naming, grouping and graphical representation techniques for such resources within a graphical user interface that the resource management program can display on a display coupled to the management station computer system.

In an environment such as a storage area network, such resources (software and hardware) often have complex physical, functional (e.g., operational) and organizational interrelationships with one another that define a resource hierarchy. For example, a high capacity data storage system resource might be comprised of many other resources such as hardware (e.g., front end and back end directors, controllers, disks, etc.) and software (e.g., operating system processes, volume constructs, etc.) components that operate within the data storage system. Certain of these resources may require access (e.g., management, control or read/write access) by different departments within an organization that operates the data storage system resource. A resource hierarchy can define, and when displayed graphically can visually convey, these physical, operational and organizational relationships between the resources in the resource hierarchy.

As a brief example operation of an embodiment of the invention, a user of the system of the invention, such as a systems or network manager or administrator, can operate a management application providing a graphical user interface according to embodiments of the invention to efficiently create and display representations of the aforementioned resources in the resource hierarchy. Embodiments of the invention provide such resource representations using a unique resource identification and grouping mechanism that efficiently conveys the identities and relationships of resources in the resource hierarchy with a minimum amount of user interaction and minimum required user sophistication.

Embodiments of the invention allow for the creation of objects that represent the aforementioned types of resources or groups of such resources. The resource hierarchy is thus represented in a computer system by creation of objects arranged in an object hierarchy. Objects in the object hierarchy can be instantiations, for example, of classes

(e.g., Java or C++ classes) in an object-oriented software environment that reference each other in parent-child relationships as required to reflect the hierarchical resource relationships. Upon creation of an object, embodiments of the invention assign each object an object identifier that includes both a simple name and a home of the object.

- 5 Embodiments provide a graphical user interface that can graphically display a representation of the object in the object hierarchy using either the simple name or both the simple name and the home of the object (called a fully qualified representation), depending upon the context in which the representation of the object is to be displayed. An object's simple name can be a short user defined name or may be an automatically
- 10 generated name (e.g., serial number of a hardware resource) that uniquely identifies the object in a home context of the object. Embodiments of the invention determine the home of an object based upon an initial creation location of the object within the object hierarchy (e.g., placement of a new object into the object hierarchy as a child of an existing object). The home for an object and thus defines that object's home context. For
- 15 example, an data storage system resource might be represented by an object which is a home to other objects that represent resources within the data storage system such as volumes, disks, controllers or the like.

A user or an automated procedure may determine other relationships (besides the home parent-child relationship) exist for an object representing a resource and thus

20 embodiments of the invention allow a representation of that object to be placed into the object hierarchy at other locations besides the location of its home context. When such embodiments operate a graphical user interface to display the object hierarchy on a display (e.g., computer monitor) of the management computer system, such embodiments can display the representation of the object using only the simple name of the object (and

25 possibly an object icon), for example, if that simple name is unique within the object hierarchy or is unique within the context of the location in which that representation of the object is displayed in the graphical user interface.

In other situations, embodiments may determine that the representation of the object in the graphical user interface is to include a both the simple name and the home of

30 the object to "fully qualify" the identity of the object which that representation represents.

In such situations, a “home condition” is said to exist requiring display of the home of the object in the graphical user interface. An example of a home condition existing is when two objects to be displayed in the same context (e.g., within the same level or location) in the object hierarchy have the same simple name, in which case an embodiment of the invention would display a representation of each object in a fully qualified manner using both the simple names (which are the same) and their homes (which are different) of the object identifiers for those objects. In this manner, a user can place representations of the same object in many places on a graphical user interface and the system of the invention can determine what parts of the objects identity (e.g., simple name and home) are required to be displayed at those locations to convey to the user the identity of the object.

Embodiments provide a suffix mechanism in the event that two home resources contain the same name. For example, if a storage system is a home object with the name “MASTER” and a host is a home object that also has the name “MASTER,” then resources such as a volume of storage called “DATA” in the MASTER storage system and a software application called “DATA” associated with the MASTER host can be represented in an object hierarchy and each will have the same simple name and the same home name. When embodiments of the invention display representations of these objects on the graphical user interface, such embodiments can display the simple name followed by the home of these objects (e.g., DATA@MASTER) and embodiments can also append a suffix to each MASTER home such as MASTER#1 and MASTER#2 to convey to the user that there are two home resources that share the same name. The representations might thus appear in the graphical user interface as DATA@MASTER#1 and DATA@MASTER#2. The #1 and #2 convey to the user that there are two home objects having the same name.

Aside from the unique naming scheme, a computer system operating an embodiment of the invention can define an object (or multiple objects) in the object hierarchy to be a group object. A group object can represent, for example, a category in the object hierarchy under which other related objects are placed in order to interrelate those other objects according to the relationship(s) defined by the group object. For example, a user might define a “UNIX” group to categorize all resources that operate the